

WHAT IS CLAIMED IS:

1. An ultrasound catheter for disrupting occlusions in blood vessels which can be guided from an access site on a patient's body to a target site adjacent an occlusion, the ultrasound catheter comprising:
 - an elongate flexible catheter body having a proximal portion, a distal portion and at least one lumen, wherein the proximal portion is stiffer than the distal portion, and the distal portion is more flexible near a distal end of the catheter body than near the proximal portion of the catheter body;
 - an ultrasound transmission member extending longitudinally through the lumen of the catheter body and having a proximal end and a distal end, wherein the ultrasound transmission member is more flexible near its distal end than near its proximal end;
 - a distal head coupled with the distal end of the ultrasound transmission member and disposed adjacent the distal end of the catheter body; and
 - at least one coupling member for coupling the ultrasound transmission member with a source of ultrasound energy.
2. An ultrasound catheter as in claim 1, wherein the distal portion is sufficiently flexible to pass, without kinking, through at least 5 cm of a blood vessel having at least one bend and an inner diameter of between about 2 mm and about 5 mm.
3. An ultrasound catheter as in claim 2, wherein the at least one bend has a radius of about 1.0 cm or smaller.
4. An ultrasound catheter as in claim 1, wherein cross-sectional diameter of the catheter body is less along the distal portion than along the proximal portion, and wherein a cross-sectional diameter of the ultrasound transmission wire is less near the distal end than near the proximal end.
5. An ultrasound catheter as in claim 4, wherein the cross-sectional diameter of the catheter body is between about 0.102 cm and about 0.178 cm along its proximal end and between about 0.076 cm and about 0.127 cm along its distal end, and the cross-sectional diameter of the ultrasound transmission member is between about 0.051 cm

and about 0.102 cm near its proximal end and between about 0.013 cm and about 0.038 cm near its distal end.

6. An ultrasound catheter as in claim 4, wherein a wall thickness of the catheter body is less along the distal portion than along the proximal portion.

7. An ultrasound catheter as in claim 6, wherein the wall thickness is between about 0.007 cm to about 0.020 cm along its proximal portion and about 0.005 cm to about 0.013 cm along its distal portion.

8. An ultrasound catheter for disrupting occlusions in blood vessels which can be guided along a guidewire from an access site on a patient's body to a target site adjacent an occlusion, the ultrasound catheter comprising:

an elongate flexible catheter body having a proximal portion, a distal portion and at least one lumen, wherein the proximal portion has a larger cross-sectional diameter than the distal portion, the proximal portion is sufficiently stiff to push the distal portion through a blood vessel having at least one bend, and the distal portion is sufficiently flexible to pass through the bend in the blood vessel;

an ultrasound transmission member extending longitudinally through the lumen of the catheter body and having a proximal end and a distal end, wherein a cross-sectional diameter of the ultrasound transmission member is less near its distal end than near its proximal end, and a distal portion of the ultrasound transmission member is sufficiently flexible to pass through the bend in the blood vessel;

a distal head coupled with the distal end of the ultrasound transmission member and disposed adjacent the distal end of the catheter body; and

at least one coupling member for coupling the ultrasound transmission member with a source of ultrasound energy.

9. An ultrasound catheter as in claim 8, wherein the distal portion is sufficiently flexible to pass, without kinking, through at least 5 cm of the blood vessel, wherein the blood vessel has an inner diameter of between about 2 mm and about 5 mm, and the at least one bend has a radius of about 1.0 cm or smaller.

10. An ultrasound catheter as in claim 8, wherein a wall thickness of the catheter body is less along the distal portion than along the proximal portion.

11. An ultrasound catheter as in claim 10, wherein the wall thickness is between about 0.007 cm to about 0.020 cm along its proximal portion and about 0.005 cm to about 0.013 cm along its distal portion.

12. An ultrasound catheter for disrupting occlusions in blood vessels which can be guided along a guidewire from an access site on a patient's body to a target site adjacent an occlusion, the ultrasound catheter comprising:

an elongate flexible catheter body having a proximal portion, a distal portion and at least one lumen, wherein the proximal portion is stiffer than the distal portion, and the distal portion is more flexible near a distal end of the catheter body than near the proximal portion of the catheter body;

an ultrasound transmission member extending longitudinally through the lumen of the catheter body and having a proximal end and a distal end, wherein the ultrasound transmission member is more flexible near its distal end than near its proximal end, and wherein the distal portion of the catheter body and the ultrasound transmission member are sufficiently flexible to conform concomitantly with at least one bend in a guidewire extended through the at least one lumen;

a distal head coupled with the distal end of the ultrasound transmission member and disposed adjacent the distal end of the catheter body; and

at least one coupling member for coupling the ultrasound transmission member with a source of ultrasound energy.

13. An ultrasound catheter as in claim 12, wherein the distal portion of the catheter body and the ultrasound transmission wire are sufficiently flexible to conform concomitantly to multiple bends in the guidewire.

14. An ultrasound catheter as in claim 13, wherein the distal portion of the catheter body and the ultrasound transmission member are sufficiently flexible to conform concomitantly to multiple bends in a blood vessel.

15. An ultrasound catheter as in claim 14, wherein the distal portion of the catheter body, the ultrasound transmission wire and the guidewire may be passed together or sequentially through the multiple bends in the blood vessel while conforming concomitantly to the multiple bends.

16. An ultrasound catheter for disrupting occlusions in blood vessels which can be guided along a guidewire from an access site on a patient's body to a target site adjacent an occlusion, the ultrasound catheter comprising:

an elongate flexible catheter body having a proximal portion, a distal portion having at least one bend, and at least one lumen, wherein the proximal portion is stiffer than the distal portion, and the distal portion is more flexible near a distal end of the catheter body than near the proximal portion of the catheter body;

an ultrasound transmission member extending longitudinally through the lumen of the catheter body and having a proximal end and a distal end, wherein the ultrasound transmission member is more flexible near its distal end than near its proximal end, wherein the ultrasound transmission member conforms to the at least one bend in the distal portion of the catheter body, and wherein the distal portion of the catheter body and the ultrasound transmission member are sufficiently flexible to conform concomitantly to at least one bend in a guidewire extended through the at least one lumen;

a distal head coupled with the distal end of the ultrasound transmission member and disposed adjacent the distal end of the catheter body; and

at least one coupling member for coupling the ultrasound transmission member with a source of ultrasound energy.

17. An ultrasound catheter as in claim 16, wherein the distal portion of the catheter body and the ultrasound transmission wire are sufficiently flexible to conform concomitantly to multiple bends in the guidewire.

18. An ultrasound catheter as in claim 17, wherein the distal portion of the catheter body and the ultrasound transmission member are sufficiently flexible to conform concomitantly to multiple bends in a blood vessel.

19. An ultrasound catheter as in claim 18, wherein the distal portion of the catheter body, the ultrasound transmission wire and the guidewire may be passed together or sequentially through the multiple bends in the blood vessel while conforming concomitantly to the multiple bends.

20. An ultrasound catheter for disrupting occlusions in blood vessels which can be guided from an access site on a patient's body to a target site adjacent an occlusion, the ultrasound catheter comprising:

an elongate flexible catheter body having a proximal portion, a distal portion, at least one lumen, and a guidewire tube disposed within the lumen, wherein the proximal portion is stiffer than the distal portion;

an ultrasound transmission member extending longitudinally through the lumen of the catheter body;

a distal head coupled with the distal end of the ultrasound transmission member and disposed adjacent the distal end of the catheter body; and

at least one coupling member for coupling the ultrasound transmission member with a source of ultrasound energy;

wherein the guidewire tube includes at least one opening within the catheter body for providing contact between a guidewire extending through the guidewire tube and the ultrasound transmission member.

21. An ultrasound catheter as in claim 20, wherein the distal portion of the catheter body is more flexible near a distal end of the catheter body than near the proximal portion of the catheter body.

22. An ultrasound catheter as in claim 20, wherein the ultrasound transmission member comprises a proximal end and a distal end, and wherein the ultrasound transmission member is more flexible near its distal end than near its proximal end.

23. An ultrasound catheter as in claim 20, wherein the guidewire contacts the ultrasound transmission wire nearer the distal end of the catheter body than a proximal end of the catheter body.

24. An ultrasound catheter as in claim 20, wherein the guidewire contacts the ultrasound transmission wire nearer a proximal end of the catheter body than the distal end of the catheter body.

25. An ultrasound catheter as in claim 20, wherein the guidewire contacts the ultrasound transmission wire near the middle of the catheter body.

26. An ultrasound catheter for disrupting occlusions in blood vessels which can be guided from an access site on a patient's body to a target site adjacent an occlusion, the ultrasound catheter comprising:

an elongate flexible catheter body having a proximal portion, a distal portion and at least one lumen, wherein the proximal portion is stiffer than the distal portion;

an ultrasound transmission member extending longitudinally through the lumen of the catheter body;

a distal head coupled with the distal end of the ultrasound transmission member and disposed adjacent the distal end of the catheter body, the distal head including:

a guidewire aperture in a center of a distal end of the distal head; and

a guidewire lumen extending through the distal head, the guidewire lumen having a different longitudinal axis than a longitudinal axis of the catheter body; and

at least one coupling member for coupling the ultrasound transmission member with a source of ultrasound energy.

27. An ultrasound catheter as in claim 26, wherein the distal portion of the catheter body is more flexible near a distal end of the catheter body than near the proximal portion of the catheter body.

28. An ultrasound catheter as in claim 26, wherein the ultrasound transmission member comprises a proximal end and a distal end, and wherein the ultrasound transmission member is more flexible near its distal end than near its proximal end.

29. An ultrasound catheter as in claim 26, wherein the guidewire lumen includes a cavity in which a distal end of a guidewire tube of the catheter body is disposed.

30. An ultrasound catheter as in claim 29, wherein the cavity extends through the distal end of the distal head, such that the distal end of the guidewire tube is flush with the distal end of the distal head.

31. An ultrasound catheter as in claim 29, wherein the cavity extends partially through the distal head, such that the distal end of the guidewire tube is disposed proximal to the distal end of the distal head.

32. An ultrasound catheter for disrupting occlusions in blood vessels which can be guided from an access site on a patient's body to a target site adjacent an occlusion, the ultrasound catheter comprising:

an elongate flexible catheter body having a proximal portion, a distal portion and at least one lumen, wherein the proximal portion is stiffer than the distal portion, and the distal portion is more flexible near a distal end of the catheter body than near the proximal portion of the catheter body;

an ultrasound transmission member extending longitudinally through the lumen of the catheter body and having a proximal end and a distal end, wherein the ultrasound transmission member is more flexible near its distal end than near its proximal end;

a distal head coupled with the distal end of the ultrasound transmission member and disposed adjacent the distal end of the catheter body; and

at least one coupling member for coupling the ultrasound transmission member with a source of ultrasound energy, the at least one coupling member comprising a housing fixedly coupled with the proximal end of the catheter body such that torque applied to the housing is transmitted along the catheter body to its distal portion.

33. A method for disrupting an occlusion in a blood vessel, the method comprising:

advancing an ultrasound catheter through a blood vessel having at least one bend, the catheter conforming concomitantly to the at least one bend, wherein advancing includes contacting an ultrasound transmission member of the ultrasound catheter with a guidewire at one or more locations within the catheter;

positioning a distal end of the ultrasound catheter adjacent an occlusion in the blood vessel; and

transmitting ultrasound energy to the ultrasound transmission member to disrupt the occlusion into multiple occlusion fragments, wherein transmitting includes transmitting ultrasound energy to the guidewire.

34. A method as in claim 33, further including removing at least some of the occlusion fragments from the blood vessel via the ultrasound catheter

35. A method as in claim 33, wherein the ultrasound catheter is advanced along the guidewire.

36. A method as in claim 33, wherein the guidewire is passed through the catheter.

37. A method as in claim 33, wherein the catheter and the guidewire are advanced together through the blood vessel.

38. A method as in claim 33, wherein the ultrasound catheter is advanced through at least one bend having a radius of about 1.0 cm or less.

39. A method as in claim 33, wherein the ultrasound catheter and the guidewire are advanced along multiple bends in the blood vessel, wherein a catheter body of the catheter, the ultrasound transmission member and the guidewire are sufficiently flexible to conform concomitantly to the multiple bends.

40. A method as in claim 33, further comprising applying radial force to a proximal housing of the ultrasound catheter to radially turn the distal end of the ultrasound catheter in the blood vessel.